

was afterwards picked up by Mr. Neave and found to have lost one hind wing. This specimen will be preserved in the Hope Department of the Oxford University Museum. The bird ate four or five *Lycænida* after it had rejected the *Acræa*. It also missed many specimens. All the butterflies were swallowed whole. The observations were still being continued when the bird was unfortunately disturbed by a party of natives.

The injury seen to have been inflicted on the *Acræa* is of special interest, because such mutilation is not uncommonly found in Lepidoptera with warning colours. Thus on April 2 Mr. W. A. Lamborn, residing in the Lagos district of West Africa, found and sent to me a conspicuous Geometrid moth, *Pithecia famula*, from which both the wings on the left side had been shorn. Disabling injuries of this description are, in my experience, rarely seen in species with procrystic colouring, but are characteristic of those with warning colours. The facts suggest the reasonable inference that a disabled procrystic species is devoured, and not rejected. Injuries that do not disable—chips out of a single wing or symmetrical notches out of both sides, injuries which leave the insect with undiminished powers of flight—are commonly found in butterflies with all kinds of patterns. The amount of this indirect evidence is even now large, and it could be obtained in almost any quantity if naturalists made a point of seeking for it, and did not discard the poorer specimens. I will refer to one more example only, and that because the species is mentioned by Mr. Banta. In 1897 I captured near Chicago a very fresh specimen of *Limnitis (Basilarchia) archippus* with a large piece torn out of one hind-wing, an injury that may reasonably be explained as the result of an attack.

I do not agree with Mr. Banta's inference that "to make a good case for mimicry in the sense in which that term is ordinarily used, the mimic *Basilarchia archippus* should be tested and found palatable" (*NATURE*, December 21, 1911, p. 243), and that we should expect birds "scarcely, if at all, [to] molest these two forms," viz. the model and its mimic (*NATURE*, May 9, 1912, p. 242). In the first place, the mimicry is probably Müllerian and not Batesian, for the mimic belongs to the genus *Limnitis* (s.l.), containing species which are themselves models for mimicry, and allied to the still more widely mimicked South American genus *Adelpha*. Secondly, it is not supposed, on any theory of mimicry, that the enemies instinctively know the qualities indicated by warning colours. This knowledge is believed to be gained by each individual enemy as the outcome of its own experience. Furthermore, it is probable that in times of special scarcity the dangers from the attacks of certain enemies would be increased by the presence of warning colours.

It should be noticed that Mr. Banta's criticism of mimicry applies equally to protective resemblance. If his facts and arguments be sound, the rock- or bark-like underside of a North American butterfly is as useless to its possessor as is, according to Mr. Banta, the resemblance of the mimic to its Danaine model.

It is necessary to make a few remarks upon the negative evidence afforded by the examination of stomachs. Conclusions in harmony with those of Mr. Banta have been reached by Mr. G. L. Bates, who has found no traces of butterflies in the stomachs of insect-eating birds of the South Cameroon (*Ibis*, ser. 9, vol. v., No. 20, October, 1911, pp. 630-1). In this case I know that Mr. Bates's inferences are considered erroneous by Mr. C. F. M. Swynnerton, who has for some years been making a special study of the relationship between birds and butterflies at Chirinda, in south-east Rhodesia. It would not be

right to anticipate the results which Mr. Swynnerton, in a truly scientific spirit, desires to establish on as solid a foundation as possible; but, as the question has been raised and dogmatic assertions have been made, I feel sure he will not object to the following brief statement, prepared in consultation with Mr. Guy Marshall:—

(1) The results of Mr. Swynnerton's earlier investigations, up to the end of 1908, were in accordance with those of Mr. Bates, and might well have justified the conclusions reached by him and by Mr. Banta.

(2) From the time when, three and a half years ago, Mr. Swynnerton first saw his way into the details of the question and the methods by which to investigate it, he has obtained the records of nearly 800 attacks made by thirty-five species of birds, belonging to thirty genera and eighteen families, upon seventy-nine species of butterflies, belonging to nine families or subfamilies.

(3) Mr. Swynnerton is thus led to conclude, in opposition to Mr. Banta, that the negative evidence believed to be supplied by the examination of stomachs should not be too implicitly relied upon. The negative evidence itself, he considers, may be accounted for in various ways:—

(a) The treatment of butterfly prey by birds. Some swallow the insect whole, but usually after masticating or beating it; some remove inconvenient portions by "worrying" like a dog or beating against perch or ground; some grasp the prey in one foot and tear off the rejected portions with the bill, eating the rest piecemeal. Except when the wings are swallowed the probability that butterflies will be recognised in the stomach-contents is extremely remote.

(b) Insectivorous birds get rid of the chitin of their prey partly in a finely divided form in the excreta, partly in pellets ejected from time to time by the mouth. Mr. Swynnerton believes that he has noted the ejection of pellets by every purely insectivorous bird kept in captivity. The wings of butterflies that were swallowed whole appeared, for the most part, both in pellets and excreta, as minute fragments that could not be easily recognised except with the microscope. After a large meal of butterflies, the pellet cast up by a captive bird would often consist of fine debris, quite unrecognisable except after a thorough and minute examination.

(c) Other groups of insects, viz. the Diptera, Orthoptera, Coleoptera, and Hymenoptera, are each of them many times as numerous in individuals as the diurnal Lepidoptera, and we should therefore expect butterflies to be proportionately far less commonly found in the stomachs of insectivorous birds.

Finally, Mr. Swynnerton has found that a recently captured adult bird shows by its behaviour that it possesses a very fair knowledge of the main types of pattern and the relative edibility of the local butterflies. That this knowledge is the outcome of individual experience is proved by the fact that it is not possessed by a bird removed from the nest when young.

EDWARD B. POULTON.

Oxford University Museum, June 3.

The Weather of 1911 and the Ultra-violet Radiations of the Sun.

IN connection with an extremely interesting discussion recently carried on in the correspondence columns of *NATURE* I ventured to direct attention (*NATURE*, December 14, 1911) to the unusual diminution of the ultra-violet radiation from the sun as a possible cause of the abnormal weather of the summer

of 1911. My intention was less to explain the particular phenomenon of this summer than to direct the attention of meteorologists to a new point of view. In so far I succeeded, for a series of letters in *NATURE* devoted attention to this point. The fullest treatment was contained in a letter from Mr. L. G. Schultz in the issue of March 14.

I should like to reply briefly to this letter, which, owing to university holidays, I have only lately seen. According to my views, his interesting observation, that for both the middle and end of the year 1911 the state of the weather in South America was diametrically opposite to that in Europe (extremely dry summer in the north with rainy winter in the south, and extremely dry summer in the south with rainy winter in the north) does not contradict my attempt at explanation, but rather proves its correctness.

With normal ultra-violet radiation from the sun, *i.e.* with normal production of condensation nuclei, the water vapour formed in the north or south hemisphere will condense again on the same hemisphere if the necessary conditions are brought about by cooling and alterations of pressure. With abnormally small production of nuclei rain will probably not cease all over the earth, as Mr. Schultz seems to conclude, for the evaporated water must come down somewhere or other, but the occurrence of condensation will be rendered more difficult. Consequently it is possible that the water evaporated on the summer half of the earth will first find the required preliminary conditions for condensation on the colder winter half, and so come down there.

In other words, if the abnormal weather of 1911 was conditioned by the decrease of ultra-violet radiation from the sun, then the abnormal dryness on the summer hemisphere had to be accompanied by abnormal rainfall on the winter hemisphere. This is exactly what Mr. Schultz has shown beyond doubt occurred not only for the period of the northern summer, but also for the period of the southern summer. Accordingly, the period of abnormally low ultra-violet radiation of the sun extended over the whole of the year 1911. CARL RAMSAUER.

Radiologisches Institut, Heidelberg, May 30.

Alleged Ultra-violet Rays from Filament Lamps.

In the note referring to the proposed electric lighting in the House of Commons by metal filament lamps, in *NATURE* of June 6 (p. 352), it is stated that "The present proposal is to use metallic filament lamps enclosed in holophane globes behind amber-coloured glass to cut off completely all ultra-violet rays." Investigations made in America and in Germany show that the ultra-violet rays from such lamps are insignificant, and are far less than in daylight giving the same illumination, and probably less than with some kinds of incandescent gas mantles.

Both physicists and electrical engineers would be interested to learn if there is any foundation for the allegation that metal filament lamps emit any appreciable ultra-violet rays or any rays which are injurious to eyesight. A. P. TROTTER.

June 8, 1912.

Earthquake of May 23.

REFERRING to the second paragraph of Fr. Sidgreaves's letter (*NATURE*, June 6), I think that in the reading of seismograms it is often very difficult to determine which is the first long wave from a distant earthquake. In the case of shocks which are powerful enough to give a definite impetus to the seismograph at the inception of each of the two preliminary phases, it would seem easier to determine the distance

of the epicentre by means of the time elapsing between the arrival of the first and of the second phase. On May 23, by this method, both horizontal booms here gave the origin at 73.8° (8200 km., roughly), which would not be far from Burmah.

F. EDWARD NORRIS.

Woodbridge Hill, Guildford, June 8.

SOLAR HALOS AND MOCK SUNS.

THERE have been recently many observations of optical phenomena in the atmosphere which can usually be identified with the halos of 22° and 46° radius or with the allied and complementary arcs and mock suns. A brief description of the principal phenomena which can be attributed to reflection and refraction of the sunlight by ice-crystals may therefore be of interest. Full accounts of such phenomena and of the theoretical explanation of their production are given in the classical memoir on halos by Bravais, in the third volume of Mascart's "Optics" and in the third part of Pernter's "Meteorological Optics."

Ice-crystals are mainly hexagonal, and may be divided into two main classes, plates or stars with short axes and needles or prisms with long axes. The resulting optical prisms have angles of 60° or 90° for the most part. The 22° halo is formed by light which has passed through those prisms of 60° , the right cross sections of which pass through the sun. The prisms must be in the position in which the rays to the sun and to the observer make equal angles with the faces, and this is possible, for yellow light, only for prisms on a cone of $21^\circ 50'$ angular radius. The 46° halo is produced in a similar way by prisms of 90° .

If there is a preponderance of crystals floating with faces vertical, the reflection of light from these faces will give rise to a horizontal circle of light passing through the sun; and at points on this circle where the light is reinforced by refracted light, there will be unusual brilliance or mock suns. Hence the name mock sun ring. Two of the mock suns are formed by light refracted through prisms of 60° . They are at 22° from the sun when it is on the horizon, and their distance increases with the altitude of the sun. The mock suns produced by prisms of 90° are similarly at 46° or more from the sun, according to its altitude.

The arcs of contact or tangent-arcs of the 22° halo are produced by refraction through prisms of 60° floating with their axes horizontal. If the sun's altitude is less than 29° , the upper and lower arcs are distinct, but for greater altitudes they are joined to form the elliptic halo circumscribing the ordinary 22° halo.

The arcs of contact of the 46° halo are formed, according to Galle and Pernter, by refraction through crystals with vertical axes oscillating about the equilibrium position; according to Bravais and Mascart by simple refraction through crystals with one face horizontal. In the former case the arc is not part of a circle, but always touches the 46° halo; in the latter it forms part of